



Biological Assessment and Stressor Study Report

Fox Creek St. Louis County, Missouri

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1.0 Introduction

At the request of the Missouri Department of Natural Resources' (MDNR) Water Protection Program (WPP), the Environmental Services Program's (ESP) Water Quality Monitoring Section (WQMS) conducted a biological assessment and stressor study of Fox Creek. Fox Creek flows through a forested and somewhat suburban upper watershed and more rural and cropland lower watershed in St. Louis County in Wildwood and Eureka, Missouri.

According to Chapter 7 of the Missouri Water Quality Standards, 10 CSR 20-7.031 (MDNR 2014b), a 7.2-mile segment of Fox Creek is designated class "P." That segment begins at sec. 30, T. 44 N., R. 03 W. and ends at its confluence with the Meramec River. Beneficial use designations are livestock and wildlife watering, protection of warm water aquatic life, human health—fish consumption, and whole body contact recreation B. In the 2012 303(d) list of impaired waters, the entire 7.2-mile class "P" section of Fox Creek is listed as impaired for unknown pollutant(s). According to the Total Maximum Daily Load (TMDL) Information Sheet (MDNR 2013b), macroinvertebrate and fish data collected through previous years suggest impairment.

1.1 Purpose

The purpose of this study was to determine if the Fox Creek macroinvertebrate community and/or stream habitat were impaired and, if so, determine the possible causes.

1.2 Objectives

- Determine if the macroinvertebrate community of Fox Creek is biologically impaired.
- Determine the habitat characteristics of Fox Creek.
- Define the water quality characteristics of Fox Creek.

1.3 Tasks

- Conduct a biological assessment of the macroinvertebrate community of Fox Creek.
- Conduct a habitat assessment of Fox Creek.
- Conduct a water quality assessment and stressor study of Fox Creek.

1.4 Null Hypotheses

- Macroinvertebrate assemblages are similar between Fox Creek and biocriteria reference (BIOREF) streams in the same EDU.
- Macroinvertebrate assemblages are similar between Fox Creek stream segments.
- Macroinvertebrate assemblages will not differ between the two sample seasons.
- Habitat quality is similar among Fox Creek stream segments.
- Habitat quality is similar between Fox Creek and biocriteria reference streams.

2.0 Study Area

Fox Creek originates in the town of Wildwood near the St. Louis/Franklin county line. It flows predominantly south through Wildwood and into Eureka until its confluence with the Meramec River. Its watershed is predominantly forest (see Table 1); however, the

downstream station is located in bottomland that is largely row cropped, and the upstream station is somewhat more immediately influenced by suburban development as it is just downstream of Interstate 44 and approximately 2 miles downstream from the Six Flags theme park in its watershed.

Fox Creek is located within the Ozark/Meramec Ecological Drainage Unit (**EDU**). An EDU is a region where biological communities and habitat conditions can be expected to be similar. See Appendix A for a map of EDUs and the sampling reaches for Fox Creek. See Table 1 for a comparison of land use for the EDU and the 12-digit Hydrologic Units (**HU**).

Table 1
 Percent Land Cover

	12-digit HUC	Impervious	Urban		Barren/ Sparsely Vegetated	Cropland	Grassland	Forest (Total)	Woody/ Herbaceous (Total)	Wetland (Total)	Open Water
			High Intensity	Low Intensity							
Ozark/Meramec EDU		1.5	0.1	2.9	0.5	1.9	27.8	58.2	5.6	0.9	1.4
Fox Cr. #s 1 and 2	071401020903	1.2	0.0	1.8	0.0	9.4	14.9	71.8	2.2	1.4	2.2

2.1 Fox Creek Site Descriptions

Two sampling locations were selected for this study. Sample stations were located in St. Louis County (see map, Appendix A). The average width and discharge measurements in cubic feet per second (**cfs**) during both survey periods are given for each Fox Creek sampling station in Table 2. The approximate drainage area for the sites in square miles (**mi²**) is presented in Table 2 as well. Drainage area was calculated using the Geographic Information System (**GIS**) software program ArcMap. Because the two stations are relatively close (within the same polygon) in the GIS format, the approximate watershed areas calculate to a similar result.

Fox Creek Station #1 (N Sur. 1897, T. 43 N., R.03 E.) is located just downstream of the Wallach Road Crossing. This site is in a “Mitigation Bank” zone in the middle of row cropped bottomland. Because of the lower gradient, riffles were few and small, and pools tended to be larger. Geographic coordinates at the upstream terminus of this station are UTM Grid 15, East 701984, and North 4262391.

Fox Creek Station #2 (SE ¼ NW ¼ sec. 04, T. 43 N., R. 03 E.) is located at the Eureka KOA Campground on Old US Highway 66 just upstream of the camping and picnic areas. This station was more Ozark-like than Station #1 with more gravel bottom riffle

and run area. Geographic coordinates at the downstream terminus of this station are UTM Grid 15, East 701266, and North 4263721.

An attempt was made to begin this study a season earlier during the fall of 2013. However the site originally selected for Station #2 was upstream of the site ultimately used for this study and was reduced to pools, and much of the streambed was dry during the fall 2013 sample season. Consequently, the study was postponed until a suitable upstream station that was more likely to be permanently flowing could be selected and sampled.

Follow-up reconnaissance of Station #2 on the day of data logger deployment at Station #1 (see Section 3.0), July 29, revealed that water had ceased to flow at Station #2, and it was mostly dry with water occurring only in isolated pools. Both stations were flowing in September during fall sampling, but discharge levels were below the reportable ≥ 0.1 cfs level, as specified in MDNR-ESP-113 *Flow Measurement in Open Channels* (MDNR 2013a). During the previous biological sampling mentioned in Section 1.0, Station #1 had ceased to flow. See photographs in Appendix B.

Table 2
Fox Creek Physical Characteristics

Station #	Mean Width (ft.)	Approx. Drainage Area (mi ²)	Spring 2014 Discharge (cfs)	Fall 2014 Discharge (cfs)
1	29	18.22	1.7	<0.1
2	40		1.4	<0.1

3.0 Methods

Sampling at Fox Creek was conducted in the spring on March 20, 2014, and in the fall on September 23, 2014. Sampling was conducted by Brian Nodine, Ken Lister, and Raissa Espejo (spring) and Brandy Bergthold (fall) of ESP. Sampling consisted of water and sediment sampling and macroinvertebrate collection. Habitat assessments on Fox Creek as well as a BIOREF station on the Meramec River were conducted during the spring sampling season.

For the stressor portion of the study, a dissolved oxygen (**DO**), temperature, and specific conductivity data logger was deployed on July 29, 2014 and retrieved on August 8, 2014, at Station #1.

3.1 Land Use

Land cover data were derived from the Thematic Mapper satellite data from 2001-2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). See Section 2.0 and Table 1 for land use information.

3.2 Habitat Assessment

A standardized habitat procedure for Riffle/Pool stream types was followed as described in the *Stream Habitat Assessment Project Procedure (SHAPP)* (MDNR 2010c). Fox Creek habitat scores were compared with the habitat score from a BIOREF station on the Meramec River conducted during the same season.

3.3 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at both stations for temperature (°C), dissolved oxygen concentration (mg/L), conductivity (µS/cm), and pH (standard units). These measurements followed Standard Operating Procedures MDNR-ESP-101 *Field Measurement of Water Temperature* (MDNR 2010b), MDNR-ESP-103 *Sample Collection and Field Analysis for Dissolved Oxygen Using a YSI Membrane Electrode Meter, Hach HQ40d LDO Probe or YSI Pro ODO Probe* (MDNR 2012b), MDNR-ESP-102 *Field Analysis for Specific Conductance* (MDNR 2010a), and MDNR-ESP-100 *Field Analysis of Water Samples for pH* (MDNR 2012a), respectively. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section (CAS) for chloride, sulfate, total phosphorus (T-P), ammonia-N (NH₃-N), nitrate + nitrite-N (NO₃ + NO₂-N), total nitrogen (T-N), non-filterable residue (NFR), dissolved magnesium (Mg), dissolved calcium (Ca), and hardness. For this study water was also collected for a suite of dissolved metals analyses that included barium (Ba), cadmium (Cd), cobalt (Co), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn). Turbidity in Nephelometric Turbidity Units (NTU) was analyzed by the WQMS.

Stream discharge in cubic feet per second (cfs) was measured at each sampling station using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated and reported per the methods in the Standard Operating Procedure MDNR-ESP-113 (MDNR 2013a).

Physicochemical data were summarized and presented in tabular form for comparison among the two Fox Creek stations and between sample seasons.

3.4 Sediment Collection and Analysis

Sediment was collected for total cadmium, lead, and zinc analysis on a dry weight basis at each station during each season. At each station a 2-ounce jar was used to collect three grab samples that were then composited into an 8-ounce sample jar. Sediment collected was representative of the sediment at each station.

Once the samples were received by CAS, they were sub-sampled down to a particle size of <2 mm for analysis.

3.5 Long-term Dissolved Oxygen, Temperature, and Specific Conductivity Measurements

A YSI Model 6920 V2 data logger [YSI Incorporated, Yellow Springs, Ohio 45387 (a subsidiary of Xylem Incorporated)] was deployed for a 10-day period during anticipated summertime low-flow periods to measure DO, temperature, and specific conductivity every 15 minutes. Data logger use was conducted following Standard Operating Procedure MDNR-ESP-104 *Continuous or Long-Term Monitoring of Water Quality Using a Dissolved Oxygen, Specific Conductivity, pH, Turbidity, Rhodamine Dye, and Temperature Data Logger* (MDNR 2014a).

3.6 Macroinvertebrate Collection and Analysis

Standardized sample collection procedures and analysis were followed as described in the *Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)* (MDNR 2012c). Three standard habitats, coarse substrate (**CS**), non-flowing water with depositional substrate (**NF**), and rootmat (**RM**) at the stream edge, were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**).

Macroinvertebrate data were analyzed in three specific ways. First, Fox Creek stations were compared to biological criteria for the Ozark/Meramec EDU. This first comparison provides an MSCI score that is used to determine whether the stream supports the protection of warm water aquatic life beneficial use designation as stated in the water quality standards. Second, a longitudinal comparison between the two Fox Creek sites was performed. Finally, a comparison was made of Fox Creek data between spring and fall sampling seasons. See Tables 9 and 10 for biological criteria for warm water reference streams in the Ozark/Meramec EDU for the fall and spring.

4.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (**QA/QC**) procedures were followed as described in pertinent Standard Operating and Project Procedures.

5.0 Data Results and Analyses

5.1 Land Use

According to MoRAP land cover files (see Table 1), the watershed land use of Fox Creek is made up mostly of forest followed by grassland and cropland.

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 3. According to project procedure guidance, the total score from the physical habitat assessment of the study sites should be at least 75 percent of the total score of the habitat assessment(s) of a BIOREF station(s) to support a similar biological community. Habitat scores for the Fox Creek stations were compared with a Meramec River BIOREF station habitat assessment conducted during the same season. Both Fox Creek stations exceeded the 75 percent threshold, so it is therefore inferred that based on habitat scores, they should support comparable biological communities.

Table 3
Habitat Scores (Spring 2014)

BIOREF Stream	Habitat Score	Fox Creek Station #	Habitat Score	% of Meramec R. BIOREF Score
Meramec River	141	1	117	83
		2	129	92

5.3 Physicochemical Data

In situ water quality measurements and turbidity are summarized in Table 4 (spring) and Table 5 (fall). Mean temperatures at Fox Creek stations were 7.0°C and 17.5°C in the spring and fall surveys, respectively.

In situ dissolved oxygen levels did not fall below the Water Quality Standards minimum concentration for warm-water and cool-water fisheries (5.0 mg/L). Typically dissolved oxygen levels are higher during the spring season when water temperatures are cooler. See Section 5.5 for further DO information.

Turbidity levels were consistent between sample stations within seasons. The sampling periods occurred during particularly low-flow events for both seasons.

Table 4
***In situ* Water Quality Measurements and Turbidity at Both Stations (Spring 2014)**

Station	Parameter				
	Temp. (°C)	Dissolved O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turbidity (NTU)
1	5.0	11.96	720	8.4	1.30
2	9.0	14.46	701	8.4	<1

Table 5
In situ Water Quality Measurements and Turbidity at Both Stations (Fall 2014)

Station	Parameter				
	Temp. (°C)	Dissolved O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turbidity (NTU)
1	17.0	7.88	571	8.0	1.67
2	18.0	6.79	609	7.7	<1

Water chemistry results including nutrients, chloride, sulfate, and dissolved metals are presented in Tables 6 and 7. All chloride, sulfate, and dissolved metals levels were below acute and chronic criteria for protection of aquatic life and drinking water supply. Nutrient levels were somewhat consistent between stations and sample seasons.

Table 6
 Nutrient, Hardness, Chloride, Sulfate, and NFR Concentrations at Both Stations

Station		Sample #	Parameter (mg/L)							
			NH ₃ -N	NO ₃ +NO ₂ -N	T-N	T-P	Hardness	Chloride	Sulfate	NFR
Spring	1	149636	0.31	0.12	0.15	<0.01	242	105	27.6	6.0
	2	149643	0.333	.034	0.28	<0.01	260	103	26.0	<5
Fall	1	1411912	<0.03	0.014	0.23	0.027	226	52.9	13.6	<5
	2	1411913	<0.03	0.11	0.18	0.047	251	57.1	14.9	<5

Table 7
 Dissolved Metal Concentrations at Both Stations

Station		Parameter (µg/L)							(mg/L)	
		Ba	Cd	Co	Cu	Pb	Ni	Zn	Ca	Mg
Spring	1	111	<0.10	<1	<0.50	<0.50	1.94	1.29	69.1	16.8
	2	117	<0.10	<1	<0.50	<0.50	1.92	1.24	74.7	17.8
Fall	1	127	<0.10	<1	0.63	<0.50	1.27	1.48	64.2	15.9
	2	129	<0.10	<1	0.56	<.050	1.19	1.85	73.8	16.1

5.4 Sediment Data

MacDonald et al. (2000) conducted an extensive literature review that suggested numeric Sediment Quality Guidelines (SQG) for toxic effects. Two SQGs were developed for each contaminant. These SQGs include Threshold Effect Concentrations (TEC), below which harmful effects are unlikely to be observed and Probable Effect Concentrations (PEC), above which harmful effects are likely to be observed. All of the sediment metals results at both stations during both sample seasons fall well below the TECs and PECs. See Table 8 for sediment data and consensus based TECs and PECs.

Table 8
 Fox Creek Sediment Results and SQGs

Sample	Sample #	Parameters (µg/kg)			Percent Moisture
		Cadmium	Lead	Zinc	
Spring #1	149642	193	11,400	46,000	31.2
Spring #2	149644	230	13,700	38,100	26.5
Fall #1	1411892	203	9,860	36,600	51.5
Fall #2	1411891	293	11,200	30,500	30.1
Consensus Based TECs		990	35,800	121,000	
Consensus Based PECs		4,980	128,000	459,000	

5.5 Long-term Dissolved Oxygen, Temperature, and Specific Conductivity

A data logger was deployed during the typically low-flow summer season prior to the fall sampling season at one of the two Fox Creek study stations (Station #1) for 10 days. This data logger collected DO (mg/L), temperature (°C) and specific conductivity (µS/cm) measurements every 15 minutes. It was deployed on July 29 at 10:30 and retrieved on August 8, 2014 at 09:45.

Dissolved oxygen results are illustrated graphically in Figure 1 for Station #1. For all DO, temperature, and specific conductivity data, refer to Appendix C.

At Station #1 DO results ranged from 2.46 to 14.80 mg/L with a mean of 6.95 mg/L. Dissolved oxygen values fell below 5.0 mg/L, the minimum allowable by the Water Quality Standards (MDNR 2014b) daily during most of the deployment period. Within approximately the last full day of the deployment period, there was a substantial rain that corresponded with DO results remaining above the 5.0 mg/L threshold. These observations contrast with the DO results during the prevailing dry, low-flow conditions earlier in the deployment period.

Dissolved oxygen minimums and maximums exhibited patterns that trended with time of day. The peak of DO levels occurred in the evening before sunset and the minimum DO levels occurred in the early morning before sunrise.

Relationships between DO and water temperature are represented for Fox Creek Station #1 in Figure 2. Average water temperature at Station #1 was 22.95 °C, with a maximum of 25.65 °C and a minimum of 20.51 °C.

Figure 1
Station #1 Long-Term Dissolved Oxygen (mg/L)

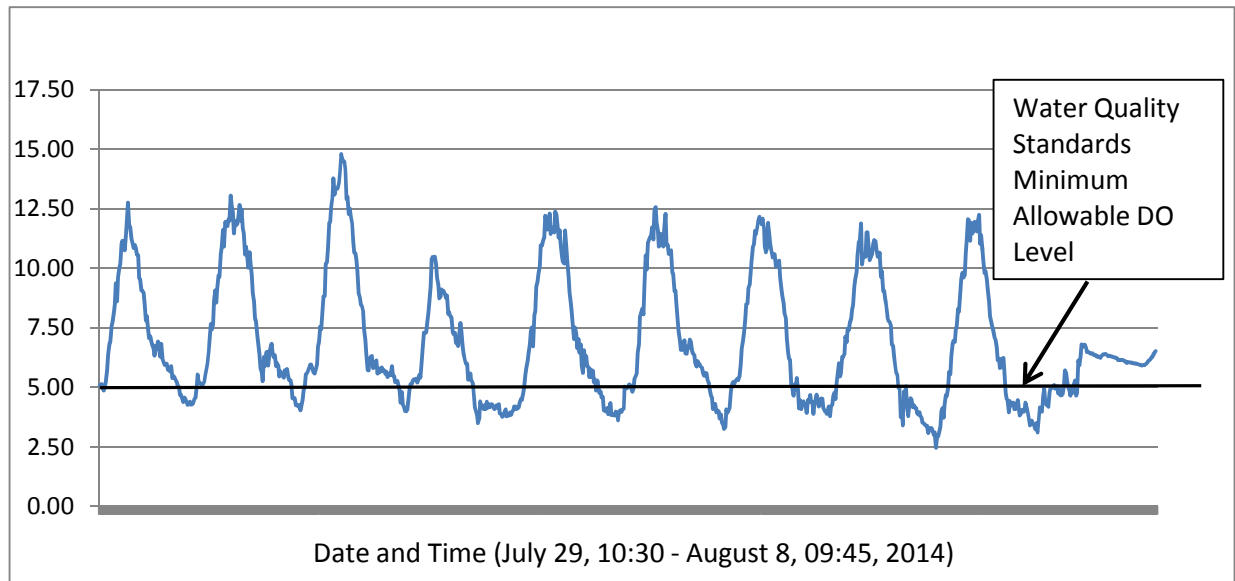
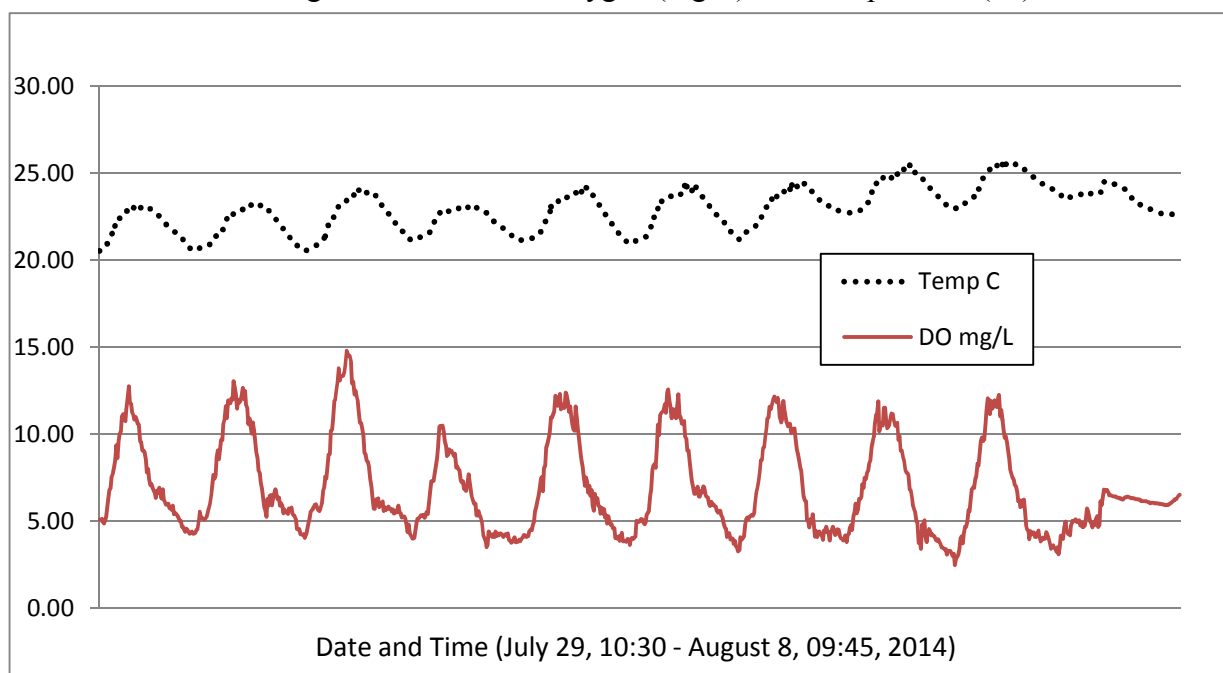
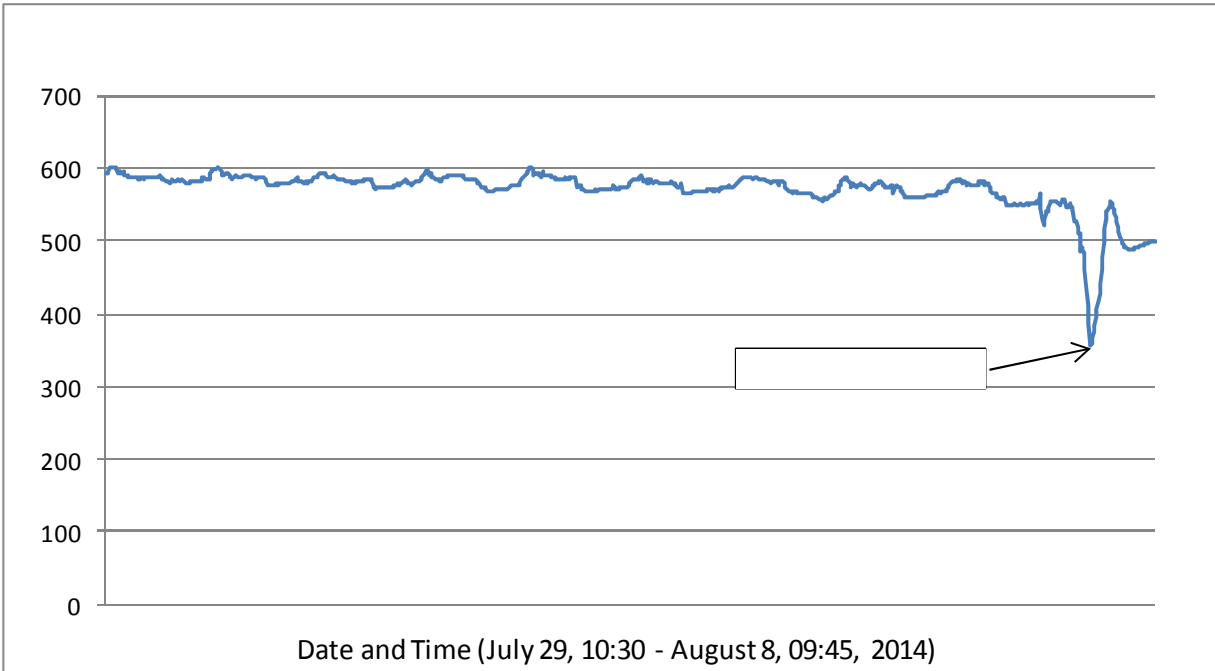


Figure 2
Station #1 Long-Term Dissolved Oxygen (mg/L) and Temperature (°C)



Long-term specific conductivity values at Station #1 during this period ranged from 357 to 603 $\mu\text{S}/\text{cm}$ with a mean of 570 $\mu\text{S}/\text{cm}$. For much of the duration of the long-term monitoring period, specific conductivity remained reasonably stable. However the minimum value occurred during the period of rain at the end of the monitoring period when the level dropped and rebounded abruptly. See Figure 3 for graphic representation of the specific conductivity values during the long-term monitoring period.

Figure 3
 Station #1 Long-Term Specific Conductivity ($\mu\text{S} / \text{cm}$)



5.6 Biological Assessment

5.6.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP evaluation used biological criteria that were calculated for the Ozark/Meramec EDU from ESP's Wadeable/Perennial Biological Reference Stream database. See Biological Criteria for Wadeable/Perennial Streams of Missouri (MDNR 2002) for more explanation. These criteria are listed for spring and fall seasons in Tables 9 and 10, respectively. Macroinvertebrate Stream Condition Index scores of 20-16 qualify as fully supporting, 14-10 as partially supporting, and 8-4 as non-supporting of the protection of aquatic life beneficial use designation.

Table 9
 Biological Criteria for Warm Water Reference Streams in the Ozark/Meramec EDU (Spring Season)

	Score = 5	Score = 3	Score = 1
TR	>93	47-93	<47
EPTT	>31	15-31	<15
BI	<5.9	5.9-7.9	>7.9
SDI	>3.33	1.67-3.33	<1.67

Table 10
 Biological Criteria for Warm Water Reference Streams in the Ozark/Meramec EDU
 (Fall Season)

Metric	Score = 5	Score = 3	Score =1
TR	>80	40-80	<40
EPTT	>23	11-23	<11
BI	<5.6	5.6-7.8	>7.8
SDI	>3.13	1.57-3.13	<1.57

5.6.2 Comparisons with Biocriteria Reference Streams in the Ozark/Meramec EDU

Macroinvertebrate Stream Condition Index scores were calculated for Fox Creek as derived from biological criteria from Ozark/Meramec EDU reference streams. The four metrics, total scores, and MSCI supportability rankings during spring and fall 2014 are presented in Tables 11 and 12, respectively.

Table 11
 Metric Values (and Scores), MSCI Scores, and Supportability Rankings for Fox Creek
 (Spring 2014)

Station #	Sample #	TR	EPTT	BI	SDI	MSCI	Supportability
1	149804	75 (3)	9 (1)	7.0 (3)	2.83 (3)	10	Partially
2	149805	48 (3)	11 (1)	7.2 (3)	1.55 (1)	8	Non

Table 12
 Metric Values (and Scores), MSCI Scores, and Supportability Rankings for Fox Creek
 (Fall 2014)

Station #	Sample #	TR	EPTT	BI	SDI	MSCI	Supportability
1	14908	71 (3)	10 (1)	6.7 (3)	3.04 (3)	10	Partially
2	14909	76 (3)	12 (3)	7.0 (3)	3.07 (3)	12	Partially

5.6.3 Fox Creek Longitudinal Comparisons

There are few differences between MSCI and metric scores longitudinally within sampling seasons between stations. However a lower score for the SDI metric for Station #2 during the spring season dropped the supportability ranking into the non-supporting category.

5.6.4 Fox Creek Seasonal Comparisons

For Station #1 there are no MSCI or metric score differences between sample seasons. However Station #2 had an MSCI score of 8 during the spring season and 12 during the fall season.

5.6.5 Macroinvertebrate Percent and Community Composition

Dominant macroinvertebrate community composition is presented in Table 13, including percent EPT and Diptera relative abundance as well as Isopoda, another relevant dominant order. The top five dominant families are also presented in Table 15 for both sampling seasons. The percent of relative abundance data were averaged from the sum of the three macroinvertebrate habitats (coarse substrate, depositional non-flow, and rootmat) sampled at each station. See Appendix D for all macroinvertebrate data.

Diptera was the dominant order at Station #1 during both sampling seasons with Chironomidae being the dominant family. At Station #2, during the spring sampling season Isopoda was the dominant order with Asellidae (*Caecidotea*) as the dominant family. The dominant order at Station #2 during the fall season was Ephemeroptera at 27 percent. Asellidae was the dominant family at 16 percent. However two Ephemeroptera families (Baetidae and Heptageniidae) represented a total of 21 percent of the sample.

Table 13
 Fox Creek 2014 Macroinvertebrate Composition

	Spring		Fall	
	Station #1	Station #2	Station #1	Station #2
% Ephemeroptera	33	0	22	27
% Plecoptera	4	10	0	0
% Trichoptera	0	1	12	3
Total EPT %	37	11	34	30
% Diptera	48	9	35	16
Alternate Dominant Order				
Isopoda		68		16
% Top Five Dominant Families (or most specific level of classification listed)				
Chironomidae	45	8	33	14
Caenidae	32		19	
Arachnida	5			
Capniidae	4	9		
Ceratopogonidae	2			
Asellidae		68		16
Crangonyctidae		7		
Gammaridae		2		
Hydropsychidae			9	
Planariidae			6	
Elmidae			6	
Physidae				13
Baetidae				12
Heptageniidae				9

Shaded cells indicate the family was not in the top five percent for that sample.
 Percentages rounded to whole numbers.

6.0 Discussion

There are no sediment quality or water quality parameters measured during the macroinvertebrate sampling events that explain the failure of the macroinvertebrate communities to score fully supporting rankings. However, long-term DO data from Station #1 indicate that DO levels fell below the minimum of 5.0 mg/L required by the Water Quality Standards. During the 10 days of long-term DO monitoring, DO fell to levels as low as just below 2.50 mg/L. These low DO events tended to occur just before sunrise, whereas the high levels tended to occur around sunset.

Among the reasons DO levels can drop during the early morning hours is due to respiration of all organisms, including algae and other aquatic plant life, during the nighttime hours when photosynthesis does not occur. Considerable fluctuations in DO can be an indication of nitrification that allows for excess algae populations. However none of the nutrient results from either season suggest a nutrient concern, especially at the pH and temperatures measured (MDNR 2014b).

As mentioned in Section 2.1, this study was postponed due to cessation of flow at the original upstream station when the first season of sampling was attempted. It was also noted that the location used for Station #2 had ceased to flow and was mostly dry during deployment of the data logger less than two months before fall sampling. As mentioned in Section 1.0, the 7.2-mile section of Fox Creek from the mouth upstream is classified as a Class "P" stream, which is defined as "Streams that maintain permanent flow even in drought conditions" (MDNR 2014b).

The listed segment of Fox Creek has exhibited other occurrences of flow cessation. During monitoring of Fox Creek by MDNR staff in the summer of 2006, the downstream station ceased to flow (as shown in the images in Appendix B). During original reconnaissance for this study in the summer of 2013, much of the upstream half of the 303(d)-listed reach of Fox Creek was either dry or pooled.

Among the physical features of streams that maintain adequate DO are flow and aeration. When there is no or minimal flow, and when there is little to no aeration of the water such as in a riffle, DO levels can decline. The noticeable rise in the minimum DO level after a substantial rain event observed during data logger deployment is evidence of the effect flow can have on DO levels.

Photosynthesis by aquatic vegetation can raise DO during daylight hours, but the stream has difficulty maintaining those levels without flow and aeration while all organisms in the ecosystem continue to undergo respiration during nighttime hours.

Even though it was more likely to cease flow, the upstream station has typical Ozark-like substrate with considerable gravel, little fine depositional material, and a noticeable gradient. By contrast, the downstream station where long-term DO was measured had more adjacent cropland, and the sample reach was characterized by having less gradient, smaller riffles, and larger pools with more depositional material relative to the upstream

station. These conditions at the downstream station can allow for more organic deposition that can also put a demand on DO.

7.0 Conclusions

Based on this study a conclusion of impairment could be made for the Fox Creek macroinvertebrate community. Given that long-term DO monitoring recorded readings that fell below Water Quality Standards almost daily over a 10-day period and no fully supporting MSCI scores were attained, it is reasonable to conclude Fox Creek's macroinvertebrate community is impaired.

It is reasonable to conclude the macroinvertebrate community is impaired due to a variety of reasons such as low flow, no flow, and low DO (likely due to low or no flow). However given the stream flow conditions described in Section 6.0, it is dubious to conclude the Fox Creek macroinvertebrate community should be determined as impaired under Fox Creek's current Class "P" classification. By all appearances Fox Creek is functionally an intermittent stream, in spite of its "P" classification. Its macroinvertebrate community in this study was compared with those of wadeable perennial BIOREF streams. Given the flow dynamics observed during this study, the defensibility of this comparison is questionable.

8.0 Summary

- The null hypothesis that macroinvertebrate assemblages are similar between Fox Creek and BIOREF streams in the same EDU is rejected.
- The null hypothesis that macroinvertebrate assemblages are similar between Fox Creek stations is accepted.
- The null hypothesis that macroinvertebrate assemblages will not differ between the two sample seasons is accepted.
- The null hypothesis that habitat quality is similar among Fox Creek stations is accepted.*
- The null hypothesis that habitat quality is similar between Fox Creek and biocriteria reference streams is accepted.

*Although it is mentioned in this report, there are some qualitative habitat differences between the two Fox Creek stations, and this conclusion was based on habitat assessment scores.

9.0 Literature Cited

- MacDonald, D. D., C. G. Ingersoll, T. A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Environmental Contamination and Toxicology* 39, 20-31.
- Missouri Department of Natural Resources. 2002. Biological Criteria for Wadeable/Perennial Streams of Missouri. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 32 pp.
- Missouri Department of Natural Resources. 2010a. Field Analysis for Specific Conductance. MDNR-ESP-102. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 15 pp.
- Missouri Department of Natural Resources. 2010b. Field Measurement of Water Temperature. MDNR-ESP-101. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 2 pp.
- Missouri Department of Natural Resources. 2010c. Stream Habitat Assessment Project Procedure (SHAPP). MDNR-ESP-032. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 40 pp.
- Missouri Department of Natural Resources. 2012a. Field Analysis of Water Samples for pH. MDNR-ESP-100. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 10 pp.
- Missouri Department of Natural Resources. 2012b. Sample Collection and Field Analysis for Dissolved Oxygen Using a YSI Membrane Electrode Meter, Hach HQ40d LDO Probe or YSI Pro ODO Probe. MDNR-ESP-103. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 13 pp.
- Missouri Department of Natural Resources. 2012c. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. MDNR-ESP-030. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 24 pp.
- Missouri Department of Natural Resources. 2013a. Flow Measurement in Open Channels. Standard Operating Procedure MDNR-ESP-113. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 9 pp.

- Missouri Department of Natural Resources. 2013b. Total Maximum Daily Load Information Sheet, Fox Creek. Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, Missouri 65102. <http://dnr.mo.gov/env/wpp/docs/1842-fox-cr-info.pdf> 2pp.
- Missouri Department of Natural Resources. 2014a. Continuous or Long-Term Monitoring of Water Quality Using a Dissolved Oxygen, Specific Conductivity, pH, Turbidity, Rhodamine Dye, and Temperature Data Logger. MDNR –ESP-104. Missouri Department of Natural Resources, Environmental Services Program, P. O. Box 176, Jefferson City, Jefferson City, Missouri 65102. 10pp.
- Missouri Department of Natural Resources. 2014b. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. Missouri Department of Natural Resources, Water Pollution Control Program, P.O. Box 176, Jefferson City, Missouri 65102. pp. 1-135.

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Date:

Approved by:

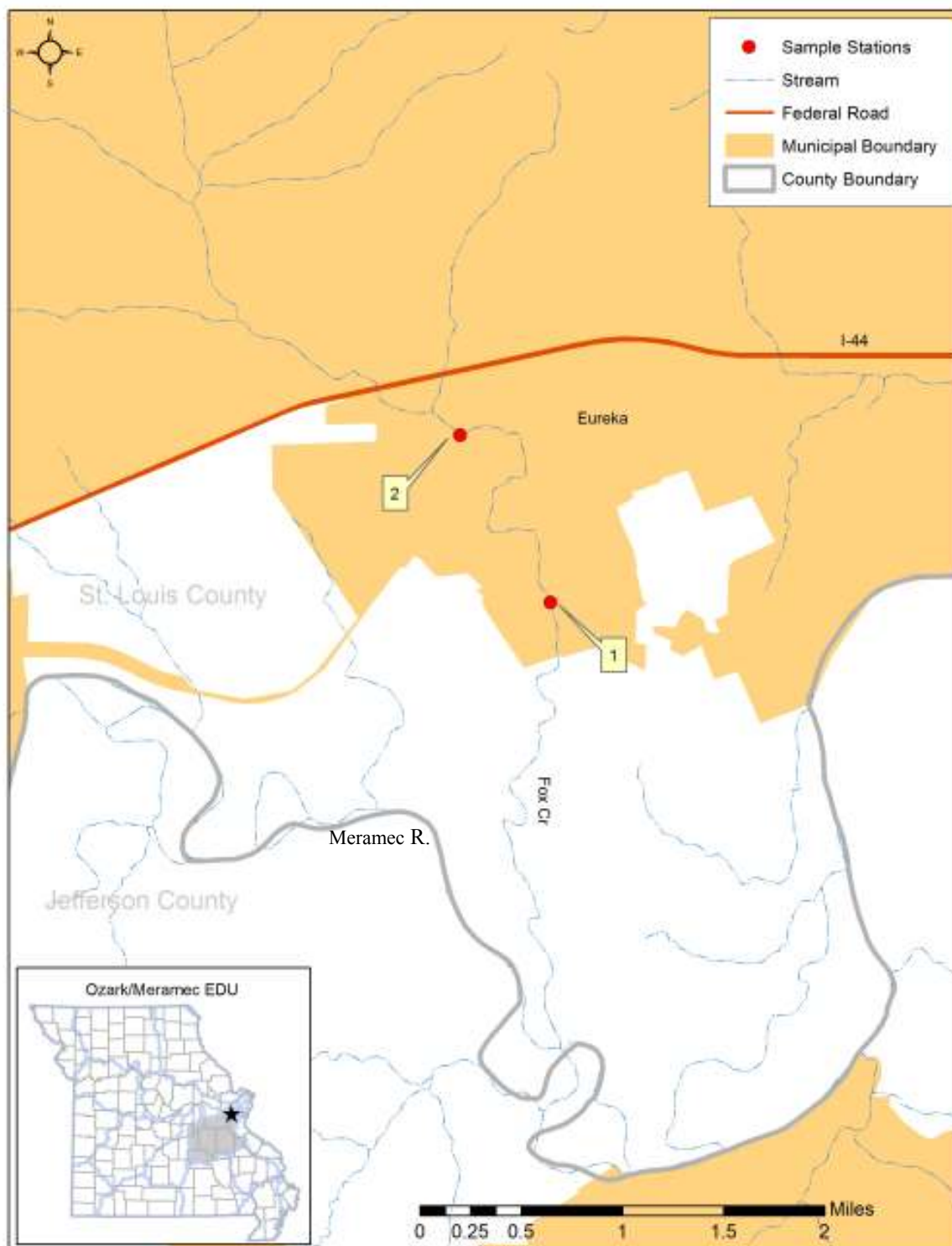
Lynn Milberg
Water Quality Monitoring Section Supervisor
Environmental Services Program

LM:bnc

cc: Dorothy Franklin, Regional Director, SLRO
Trish Rielly, QAPP Project Manager, WPP

Appendix A

Fox Creek Study Area Map



Appendix B

Photographic Images



Fox Creek Station #2, July 29, 2014 (upstream view)



Fox Creek Station #2, July 29, 2014 (downstream view)



Fox Creek Station #1, Summer 2006 (Photo Courtesy: Mike Irwin, MDNR)

Appendix C

Dissolved Oxygen, Temperature, and Specific Conductivity Data Logger Results

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
07/29/2014 10:30:32	20.53	5.08	593
07/29/2014 10:45:32	20.59	5.09	593
07/29/2014 11:00:32	20.61	5.13	592
07/29/2014 11:15:32	20.60	4.94	596
07/29/2014 11:30:32	20.62	4.87	600
07/29/2014 11:45:32	20.71	5.04	601
07/29/2014 12:00:32	20.80	5.26	601
07/29/2014 12:15:32	20.93	5.73	600
07/29/2014 12:30:32	21.07	6.38	602
07/29/2014 12:45:32	21.27	6.80	601
07/29/2014 13:00:32	21.41	6.93	599
07/29/2014 13:15:32	21.45	7.57	593
07/29/2014 13:30:32	21.74	7.76	595
07/29/2014 13:45:32	21.63	8.14	595
07/29/2014 14:00:32	22.05	8.48	594
07/29/2014 14:15:32	22.00	9.37	594
07/29/2014 14:30:32	22.17	8.61	594
07/29/2014 14:45:32	22.18	9.63	595
07/29/2014 15:00:32	22.41	10.02	592
07/29/2014 15:15:32	22.45	10.18	590
07/29/2014 15:30:32	22.55	11.02	590
07/29/2014 15:45:32	22.73	11.15	589
07/29/2014 16:00:32	22.71	10.98	588
07/29/2014 16:15:32	22.81	10.75	588
07/29/2014 16:30:32	22.80	11.45	588
07/29/2014 16:45:32	22.87	12.08	587
07/29/2014 17:00:32	22.86	12.76	588
07/29/2014 17:15:32	22.94	11.81	586
07/29/2014 17:30:32	22.88	11.73	586
07/29/2014 17:45:32	22.89	11.25	586
07/29/2014 18:00:32	23.08	11.08	584
07/29/2014 18:15:32	22.89	10.84	586
07/29/2014 18:30:32	22.91	10.99	586
07/29/2014 18:45:32	22.94	10.82	587
07/29/2014 19:00:32	23.03	10.58	587
07/29/2014 19:15:32	23.13	10.54	586
07/29/2014 19:30:32	23.03	9.58	587
07/29/2014 19:45:32	23.01	9.55	588
07/29/2014 20:00:32	23.05	9.07	588
07/29/2014 20:15:32	23.05	9.06	588
07/29/2014 20:30:32	23.13	8.96	588
07/29/2014 20:45:32	23.08	8.54	588
07/29/2014 21:00:32	23.06	7.81	589
07/29/2014 21:15:32	23.07	7.99	588
07/29/2014 21:30:32	23.01	7.42	589
07/29/2014 21:45:32	22.95	7.07	589
07/29/2014 22:00:32	22.90	7.14	588

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
07/29/2014 22:15:32	22.82	6.92	588
07/29/2014 22:30:32	22.81	6.79	589
07/29/2014 22:45:32	22.79	6.64	589
07/29/2014 23:00:32	22.75	6.33	586
07/29/2014 23:15:32	22.67	6.75	586
07/29/2014 23:30:32	22.62	6.63	585
07/29/2014 23:45:32	22.51	6.92	585
07/30/2014 00:00:32	22.42	6.63	585
07/30/2014 00:15:32	22.36	6.30	582
07/30/2014 00:30:32	22.27	6.83	583
07/30/2014 00:45:32	22.19	6.22	582
07/30/2014 01:00:32	22.13	6.09	581
07/30/2014 01:15:32	22.06	5.94	579
07/30/2014 01:30:32	22.00	5.94	582
07/30/2014 01:45:32	21.94	6.00	584
07/30/2014 02:00:32	21.86	5.74	581
07/30/2014 02:15:32	21.83	5.74	582
07/30/2014 02:30:32	21.76	5.66	582
07/30/2014 02:45:32	21.72	5.89	583
07/30/2014 03:00:32	21.68	5.39	584
07/30/2014 03:15:32	21.63	5.49	584
07/30/2014 03:30:32	21.58	5.42	583
07/30/2014 03:45:32	21.55	5.33	583
07/30/2014 04:00:32	21.47	5.21	584
07/30/2014 04:15:32	21.46	5.01	583
07/30/2014 04:30:32	21.36	5.02	582
07/30/2014 04:45:32	21.28	4.68	579
07/30/2014 05:00:32	21.19	4.69	580
07/30/2014 05:15:32	21.11	4.52	579
07/30/2014 05:30:32	21.00	4.38	579
07/30/2014 05:45:32	20.96	4.57	580
07/30/2014 06:00:32	20.87	4.51	581
07/30/2014 06:15:32	20.75	4.35	582
07/30/2014 06:30:32	20.71	4.27	581
07/30/2014 06:45:32	20.66	4.33	581
07/30/2014 07:00:32	20.65	4.40	582
07/30/2014 07:15:32	20.60	4.27	581
07/30/2014 07:30:32	20.55	4.29	582
07/30/2014 07:45:32	20.51	4.34	582
07/30/2014 08:00:32	20.54	4.50	581
07/30/2014 08:15:32	20.57	4.55	581
07/30/2014 08:30:32	20.65	5.04	582
07/30/2014 08:45:32	20.69	5.54	587
07/30/2014 09:00:32	20.70	5.21	587
07/30/2014 09:15:32	20.73	5.19	586
07/30/2014 09:30:32	20.73	5.12	585
07/30/2014 09:45:32	20.74	5.08	585

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
07/30/2014 10:00:32	20.79	5.15	585
07/30/2014 10:15:32	20.82	5.23	585
07/30/2014 10:30:32	20.88	5.50	593
07/30/2014 10:45:32	20.87	5.78	597
07/30/2014 11:00:32	20.93	6.01	598
07/30/2014 11:15:32	20.96	6.52	599
07/30/2014 11:30:32	21.06	6.98	599
07/30/2014 11:45:32	21.16	7.66	599
07/30/2014 12:00:32	21.14	7.43	601
07/30/2014 12:15:32	21.35	7.64	600
07/30/2014 12:30:32	21.47	8.65	599
07/30/2014 12:45:32	21.55	9.07	599
07/30/2014 13:00:32	21.73	8.56	596
07/30/2014 13:15:32	21.77	9.15	589
07/30/2014 13:30:32	21.72	9.69	590
07/30/2014 13:45:32	21.75	9.66	590
07/30/2014 14:00:32	21.78	10.60	593
07/30/2014 14:15:32	22.01	10.89	594
07/30/2014 14:30:32	22.25	11.61	594
07/30/2014 14:45:32	22.39	10.91	591
07/30/2014 15:00:32	22.62	11.95	587
07/30/2014 15:15:32	22.64	11.78	586
07/30/2014 15:30:32	22.62	11.78	586
07/30/2014 15:45:32	22.55	12.05	588
07/30/2014 16:00:32	22.66	11.99	587
07/30/2014 16:15:32	22.64	13.06	589
07/30/2014 16:30:32	22.72	12.65	588
07/30/2014 16:45:32	22.74	12.34	588
07/30/2014 17:00:32	22.73	11.47	589
07/30/2014 17:15:32	22.80	11.99	588
07/30/2014 17:30:32	22.89	11.81	587
07/30/2014 17:45:32	22.89	11.88	589
07/30/2014 18:00:32	22.87	12.16	590
07/30/2014 18:15:32	22.93	12.66	590
07/30/2014 18:30:32	22.87	12.01	590
07/30/2014 18:45:32	22.96	12.47	590
07/30/2014 19:00:32	22.98	11.67	590
07/30/2014 19:15:32	22.97	11.46	590
07/30/2014 19:30:32	23.03	10.58	589
07/30/2014 19:45:32	23.11	10.90	589
07/30/2014 20:00:32	23.19	10.47	587
07/30/2014 20:15:32	23.15	10.03	587
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07/30/2014 20:45:32	23.22	10.23	586
07/30/2014 21:00:32	23.29	9.70	586
07/30/2014 21:15:32	23.23	8.97	586
07/30/2014 21:30:32	23.23	8.61	586

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
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07/30/2014 22:15:32	23.14	7.22	587
07/30/2014 22:30:32	23.09	6.85	587
07/30/2014 22:45:32	23.15	6.39	587
07/30/2014 23:00:32	23.14	5.82	585
07/30/2014 23:15:32	23.08	5.65	583
07/30/2014 23:30:32	22.99	5.25	576
07/30/2014 23:45:32	22.93	6.28	576
07/31/2014 00:00:32	22.86	5.90	576
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07/31/2014 00:30:32	22.71	6.50	577
07/31/2014 00:45:32	22.59	5.91	577
07/31/2014 01:00:32	22.55	6.37	577
07/31/2014 01:15:32	22.48	6.63	577
07/31/2014 01:30:32	22.38	6.82	579
07/31/2014 01:45:32	22.30	6.43	578
07/31/2014 02:00:32	22.22	6.26	578
07/31/2014 02:15:32	22.16	6.35	579
07/31/2014 02:30:32	22.06	5.89	578
07/31/2014 02:45:32	21.97	6.01	578
07/31/2014 03:00:32	21.87	5.91	579
07/31/2014 03:15:32	21.81	5.45	578
07/31/2014 03:30:32	21.69	5.68	579
07/31/2014 03:45:32	21.61	5.52	579
07/31/2014 04:00:32	21.51	5.49	579
07/31/2014 04:15:32	21.45	5.41	579
07/31/2014 04:30:32	21.34	5.72	580
07/31/2014 04:45:32	21.29	5.66	580
07/31/2014 05:00:32	21.20	5.77	581
07/31/2014 05:15:32	21.18	5.43	581
07/31/2014 05:30:32	21.13	5.32	583
07/31/2014 05:45:32	21.05	5.30	584
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07/31/2014 06:30:32	20.75	4.52	583
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07/31/2014 07:00:32	20.73	4.25	581
07/31/2014 07:15:32	20.65	4.24	581
07/31/2014 07:30:32	20.62	4.19	581
07/31/2014 07:45:32	20.58	4.26	581
07/31/2014 08:00:32	20.58	4.03	581
07/31/2014 08:15:32	20.56	4.22	581
07/31/2014 08:30:32	20.59	4.48	581
07/31/2014 08:45:32	20.68	4.88	581
07/31/2014 09:00:32	20.72	5.08	582
07/31/2014 09:15:32	20.76	5.55	581

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
07/31/2014 09:30:32	20.77	5.59	581
07/31/2014 09:45:32	20.79	5.69	583
07/31/2014 10:00:32	20.80	5.79	587
07/31/2014 10:15:32	20.83	5.96	588
07/31/2014 10:30:32	20.86	5.96	589
07/31/2014 10:45:32	20.86	5.77	589
07/31/2014 11:00:32	20.87	5.63	591
07/31/2014 11:15:32	20.89	5.58	593
07/31/2014 11:30:32	20.93	5.72	593
07/31/2014 11:45:32	21.03	5.99	593
07/31/2014 12:00:32	21.15	6.72	594
07/31/2014 12:15:32	21.25	6.91	594
07/31/2014 12:30:32	21.38	7.54	592
07/31/2014 12:45:32	21.44	7.44	591
07/31/2014 13:00:32	21.92	8.22	588
07/31/2014 13:15:32	22.02	8.81	587
07/31/2014 13:30:32	22.01	8.85	588
07/31/2014 13:45:32	22.31	10.17	587
07/31/2014 14:00:32	22.32	10.25	587
07/31/2014 14:15:32	22.43	10.82	587
07/31/2014 14:30:32	22.53	11.89	591
07/31/2014 14:45:32	22.72	11.95	589
07/31/2014 15:00:32	22.91	12.57	588
07/31/2014 15:15:32	23.02	12.93	586
07/31/2014 15:30:32	23.10	13.78	586
07/31/2014 15:45:32	23.09	13.09	586
07/31/2014 16:00:32	23.18	13.34	585
07/31/2014 16:15:32	23.25	13.34	585
07/31/2014 16:30:32	23.23	13.36	584
07/31/2014 16:45:32	23.33	13.58	584
07/31/2014 17:00:32	23.33	14.03	584
07/31/2014 17:15:32	23.44	14.80	583
07/31/2014 17:30:32	23.40	14.63	583
07/31/2014 17:45:32	23.43	14.49	582
07/31/2014 18:00:32	23.50	14.48	582
07/31/2014 18:15:32	23.47	14.15	582
07/31/2014 18:30:32	23.55	12.91	582
07/31/2014 18:45:32	23.74	13.00	580
07/31/2014 19:00:32	23.78	12.27	580
07/31/2014 19:15:32	23.96	12.50	580
07/31/2014 19:30:32	24.03	12.12	581
07/31/2014 19:45:32	24.18	11.89	580
07/31/2014 20:00:32	23.99	11.13	582
07/31/2014 20:15:32	23.95	10.66	583
07/31/2014 20:30:32	24.09	10.62	582
07/31/2014 20:45:32	24.01	10.35	583
07/31/2014 21:00:32	23.99	9.88	583

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
07/31/2014 21:15:32	23.92	8.92	583
07/31/2014 21:30:32	23.93	8.80	584
07/31/2014 21:45:32	23.89	8.47	584
07/31/2014 22:00:32	23.84	8.40	585
07/31/2014 22:15:32	23.81	8.15	585
07/31/2014 22:30:32	23.80	7.43	586
07/31/2014 22:45:32	23.90	6.98	585
07/31/2014 23:00:32	23.89	6.37	585
07/31/2014 23:15:32	23.87	5.72	581
07/31/2014 23:30:32	23.79	5.72	577
07/31/2014 23:45:32	23.68	6.20	573
08/01/2014 00:00:32	23.63	6.29	572
08/01/2014 00:15:32	23.47	6.31	573
08/01/2014 00:30:32	23.39	5.81	572
08/01/2014 00:45:32	23.30	5.90	573
08/01/2014 01:00:32	23.19	6.03	573
08/01/2014 01:15:32	23.10	6.14	573
08/01/2014 01:30:32	22.99	5.58	573
08/01/2014 01:45:32	22.91	5.80	574
08/01/2014 02:00:32	22.81	5.63	573
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08/01/2014 02:30:32	22.68	5.84	574
08/01/2014 02:45:32	22.58	5.69	574
08/01/2014 03:00:32	22.53	5.71	574
08/01/2014 03:15:32	22.41	5.56	574
08/01/2014 03:30:32	22.35	5.66	575
08/01/2014 03:45:32	22.24	5.43	575
08/01/2014 04:00:32	22.15	5.47	575
08/01/2014 04:15:32	22.06	5.61	576
08/01/2014 04:30:32	22.01	5.52	576
08/01/2014 04:45:32	21.91	5.89	577
08/01/2014 05:00:32	21.81	5.50	577
08/01/2014 05:15:32	21.78	5.45	578
08/01/2014 05:30:32	21.70	5.22	578
08/01/2014 05:45:32	21.63	5.27	578
08/01/2014 06:00:32	21.60	5.26	580
08/01/2014 06:15:32	21.48	5.10	582
08/01/2014 06:30:32	21.45	4.85	582
08/01/2014 06:45:32	21.41	4.36	583
08/01/2014 07:00:32	21.35	4.80	584
08/01/2014 07:15:32	21.20	4.27	583
08/01/2014 07:30:32	21.22	4.17	581
08/01/2014 07:45:32	21.15	4.01	580
08/01/2014 08:00:32	21.13	3.99	579
08/01/2014 08:15:32	21.16	4.06	578
08/01/2014 08:30:32	21.22	4.42	578
08/01/2014 08:45:32	21.27	4.92	579

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
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08/01/2014 09:15:32	21.33	5.15	582
08/01/2014 09:30:32	21.33	5.27	583
08/01/2014 09:45:32	21.34	5.34	583
08/01/2014 10:00:32	21.35	5.31	583
08/01/2014 10:15:32	21.40	5.36	583
08/01/2014 10:30:32	21.38	5.20	584
08/01/2014 10:45:32	21.42	5.35	587
08/01/2014 11:00:32	21.46	5.52	591
08/01/2014 11:15:32	21.50	5.42	593
08/01/2014 11:30:32	21.55	6.09	597
08/01/2014 11:45:32	21.61	6.63	599
08/01/2014 12:00:32	21.71	7.30	599
08/01/2014 12:15:32	21.84	7.28	591
08/01/2014 12:30:32	22.01	7.31	594
08/01/2014 12:45:32	22.20	7.68	592
08/01/2014 13:00:32	22.41	8.14	588
08/01/2014 13:15:32	22.43	8.61	588
08/01/2014 13:30:32	22.64	9.23	586
08/01/2014 13:45:32	22.69	10.40	585
08/01/2014 14:00:32	22.74	10.48	586
08/01/2014 14:15:32	22.65	10.39	586
08/01/2014 14:30:32	22.60	10.49	584
08/01/2014 14:45:32	22.66	10.15	583
08/01/2014 15:00:32	22.70	9.61	583
08/01/2014 15:15:32	22.68	9.31	585
08/01/2014 15:30:32	22.68	8.74	587
08/01/2014 15:45:32	22.75	8.82	587
08/01/2014 16:00:32	22.87	9.12	588
08/01/2014 16:15:32	22.91	9.02	588
08/01/2014 16:30:32	22.92	9.04	589
08/01/2014 16:45:32	22.94	8.91	590
08/01/2014 17:00:32	23.00	8.77	590
08/01/2014 17:15:32	22.98	8.87	590
08/01/2014 17:30:32	22.98	8.08	590
08/01/2014 17:45:32	22.96	8.16	590
08/01/2014 18:00:32	23.00	7.99	590
08/01/2014 18:15:32	22.95	7.93	591
08/01/2014 18:30:32	22.94	7.33	591
08/01/2014 18:45:32	22.89	7.23	591
08/01/2014 19:00:32	22.96	7.28	591
08/01/2014 19:15:32	23.01	6.87	590
08/01/2014 19:30:32	23.00	6.85	590
08/01/2014 19:45:32	23.02	6.73	590
08/01/2014 20:00:32	22.99	7.19	589
08/01/2014 20:15:32	23.10	7.70	588
08/01/2014 20:30:32	23.15	7.36	586

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/01/2014 20:45:32	23.15	6.70	585
08/01/2014 21:00:32	23.13	6.40	585
08/01/2014 21:15:32	23.06	6.18	585
08/01/2014 21:30:32	23.13	6.01	584
08/01/2014 21:45:32	23.08	6.00	585
08/01/2014 22:00:32	23.01	5.33	585
08/01/2014 22:15:32	23.01	5.32	585
08/01/2014 22:30:32	23.00	5.58	585
08/01/2014 22:45:32	22.99	5.32	585
08/01/2014 23:00:32	22.95	5.20	585
08/01/2014 23:15:32	22.94	4.90	581
08/01/2014 23:30:32	22.88	4.18	580
08/01/2014 23:45:32	22.83	4.05	579
08/02/2014 00:00:32	22.78	3.84	574
08/02/2014 00:15:32	22.72	3.49	573
08/02/2014 00:30:32	22.68	3.67	573
08/02/2014 00:45:32	22.63	4.40	573
08/02/2014 01:00:32	22.55	4.23	575
08/02/2014 01:15:32	22.47	4.18	571
08/02/2014 01:30:32	22.38	4.09	569
08/02/2014 01:45:32	22.27	4.25	569
08/02/2014 02:00:32	22.20	4.09	569
08/02/2014 02:15:32	22.14	4.40	569
08/02/2014 02:30:32	22.09	4.14	569
08/02/2014 02:45:32	22.05	4.29	569
08/02/2014 03:00:32	21.99	4.17	569
08/02/2014 03:15:32	21.95	4.29	570
08/02/2014 03:30:32	21.91	4.27	570
08/02/2014 03:45:32	21.88	4.17	572
08/02/2014 04:00:32	21.82	4.09	571
08/02/2014 04:15:32	21.76	4.19	571
08/02/2014 04:30:32	21.73	4.25	571
08/02/2014 04:45:32	21.66	4.14	571
08/02/2014 05:00:32	21.60	4.29	571
08/02/2014 05:15:32	21.55	3.90	571
08/02/2014 05:30:32	21.48	3.87	571
08/02/2014 05:45:32	21.45	3.76	571
08/02/2014 06:00:32	21.35	3.81	572
08/02/2014 06:15:32	21.31	3.95	572
08/02/2014 06:30:32	21.25	4.07	575
08/02/2014 06:45:32	21.21	3.78	575
08/02/2014 07:00:32	21.19	3.81	575
08/02/2014 07:15:32	21.19	3.82	576
08/02/2014 07:30:32	21.14	3.94	577
08/02/2014 07:45:32	21.16	3.84	577
08/02/2014 08:00:32	21.17	3.98	577
08/02/2014 08:15:32	21.20	4.05	577

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/02/2014 08:30:32	21.22	4.19	577
08/02/2014 08:45:32	21.18	4.19	577
08/02/2014 09:00:32	21.17	4.08	579
08/02/2014 09:15:32	21.17	4.11	584
08/02/2014 09:30:32	21.18	4.15	584
08/02/2014 09:45:32	21.21	4.40	588
08/02/2014 10:00:32	21.24	4.52	590
08/02/2014 10:15:32	21.28	4.48	590
08/02/2014 10:30:32	21.27	4.75	593
08/02/2014 10:45:32	21.31	4.99	596
08/02/2014 11:00:32	21.30	5.54	600
08/02/2014 11:15:32	21.35	5.82	602
08/02/2014 11:30:32	21.42	6.10	603
08/02/2014 11:45:32	21.44	6.45	602
08/02/2014 12:00:32	21.55	6.80	599
08/02/2014 12:15:32	21.64	7.34	590
08/02/2014 12:30:32	21.83	7.53	593
08/02/2014 12:45:32	22.03	6.72	593
08/02/2014 13:00:32	22.12	8.02	593
08/02/2014 13:15:32	22.19	8.21	589
08/02/2014 13:30:32	22.35	9.22	592
08/02/2014 13:45:32	22.52	9.46	589
08/02/2014 14:00:32	22.56	9.79	590
08/02/2014 14:15:32	22.67	10.09	595
08/02/2014 14:30:32	23.07	10.96	591
08/02/2014 14:45:32	23.05	10.95	592
08/02/2014 15:00:32	23.13	11.15	590
08/02/2014 15:15:32	23.28	11.30	589
08/02/2014 15:30:32	23.31	12.21	590
08/02/2014 15:45:32	23.42	12.04	589
08/02/2014 16:00:32	23.36	11.63	589
08/02/2014 16:15:32	23.41	11.85	588
08/02/2014 16:30:32	23.46	12.30	588
08/02/2014 16:45:32	23.52	11.43	587
08/02/2014 17:00:32	23.54	11.56	587
08/02/2014 17:15:32	23.62	11.70	585
08/02/2014 17:30:32	23.56	11.50	585
08/02/2014 17:45:32	23.56	12.38	585
08/02/2014 18:00:32	23.60	12.24	585
08/02/2014 18:15:32	23.63	11.85	585
08/02/2014 18:30:32	23.61	11.29	585
08/02/2014 18:45:32	23.65	11.60	586
08/02/2014 19:00:32	23.65	11.04	586
08/02/2014 19:15:32	23.71	10.54	585
08/02/2014 19:30:32	23.72	10.28	586
08/02/2014 19:45:32	23.82	10.20	586
08/02/2014 20:00:32	23.82	11.59	587

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/02/2014 20:15:32	24.04	10.88	585
08/02/2014 20:30:32	23.86	10.29	588
08/02/2014 20:45:32	23.92	9.67	587
08/02/2014 21:00:32	23.87	8.98	589
08/02/2014 21:15:32	23.95	8.54	588
08/02/2014 21:30:32	23.91	8.12	589
08/02/2014 21:45:32	23.88	7.63	589
08/02/2014 22:00:32	24.27	7.04	575
08/02/2014 22:15:32	24.23	7.52	574
08/02/2014 22:30:32	24.06	7.25	576
08/02/2014 22:45:32	24.02	6.65	577
08/02/2014 23:00:32	24.05	7.03	572
08/02/2014 23:15:32	23.93	6.45	572
08/02/2014 23:30:32	23.90	6.80	570
08/02/2014 23:45:32	23.78	5.91	569
08/03/2014 00:00:32	23.68	5.60	568
08/03/2014 00:15:32	23.61	6.57	569
08/03/2014 00:30:32	23.47	6.13	568
08/03/2014 00:45:32	23.38	6.31	569
08/03/2014 01:00:32	23.27	5.89	569
08/03/2014 01:15:32	23.15	5.86	569
08/03/2014 01:30:32	23.06	5.43	568
08/03/2014 01:45:32	22.97	5.76	569
08/03/2014 02:00:32	22.88	5.44	569
08/03/2014 02:15:32	22.76	5.69	570
08/03/2014 02:30:32	22.69	5.21	569
08/03/2014 02:45:32	22.53	5.32	570
08/03/2014 03:00:32	22.49	4.86	570
08/03/2014 03:15:32	22.44	5.28	570
08/03/2014 03:30:32	22.29	5.04	571
08/03/2014 03:45:32	22.22	4.78	572
08/03/2014 04:00:32	22.12	4.83	572
08/03/2014 04:15:32	21.98	4.59	572
08/03/2014 04:30:32	21.89	4.60	572
08/03/2014 04:45:32	21.80	4.04	571
08/03/2014 05:00:32	21.74	4.01	571
08/03/2014 05:15:32	21.64	3.99	571
08/03/2014 05:30:32	21.55	4.13	571
08/03/2014 05:45:32	21.49	3.87	572
08/03/2014 06:00:32	21.41	4.17	574
08/03/2014 06:15:32	21.34	4.34	577
08/03/2014 06:30:32	21.23	3.83	574
08/03/2014 06:45:32	21.19	3.88	572
08/03/2014 07:00:32	21.11	3.83	572
08/03/2014 07:15:32	21.08	3.82	571
08/03/2014 07:30:32	21.09	3.98	572
08/03/2014 07:45:32	20.96	3.88	573

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/03/2014 08:00:32	20.95	3.62	573
08/03/2014 08:15:32	20.95	3.99	573
08/03/2014 08:30:32	20.98	4.03	573
08/03/2014 08:45:32	21.00	3.97	573
08/03/2014 09:00:32	21.04	4.07	573
08/03/2014 09:15:32	21.11	4.11	574
08/03/2014 09:30:32	21.16	5.03	575
08/03/2014 09:45:32	21.22	4.99	576
08/03/2014 10:00:32	21.23	4.96	579
08/03/2014 10:15:32	21.24	5.02	583
08/03/2014 10:30:32	21.27	5.12	582
08/03/2014 10:45:32	21.28	5.10	584
08/03/2014 11:00:32	21.31	4.94	584
08/03/2014 11:15:32	21.30	4.82	585
08/03/2014 11:30:32	21.34	4.96	585
08/03/2014 11:45:32	21.46	5.38	585
08/03/2014 12:00:32	21.49	5.50	586
08/03/2014 12:15:32	21.64	5.61	587
08/03/2014 12:30:32	21.86	6.46	590
08/03/2014 12:45:32	21.94	6.82	589
08/03/2014 13:00:32	22.42	7.98	585
08/03/2014 13:15:32	22.39	8.18	581
08/03/2014 13:30:32	22.54	8.30	581
08/03/2014 13:45:32	22.49	8.07	585
08/03/2014 14:00:32	22.84	9.28	580
08/03/2014 14:15:32	22.98	10.54	580
08/03/2014 14:30:32	22.89	9.95	584
08/03/2014 14:45:32	23.09	11.09	585
08/03/2014 15:00:32	23.39	11.22	582
08/03/2014 15:15:32	23.39	11.31	580
08/03/2014 15:30:32	23.39	11.38	580
08/03/2014 15:45:32	23.41	11.73	581
08/03/2014 16:00:32	23.46	11.22	581
08/03/2014 16:15:32	23.54	12.37	581
08/03/2014 16:30:32	23.62	12.57	580
08/03/2014 16:45:32	23.61	11.93	580
08/03/2014 17:00:32	23.64	11.60	580
08/03/2014 17:15:32	23.73	10.91	579
08/03/2014 17:30:32	23.69	11.45	579
08/03/2014 17:45:32	23.69	11.02	579
08/03/2014 18:00:32	23.71	11.42	579
08/03/2014 18:15:32	23.72	10.92	579
08/03/2014 18:30:32	23.78	11.71	579
08/03/2014 18:45:32	23.74	12.29	580
08/03/2014 19:00:32	23.74	10.98	578
08/03/2014 19:15:32	23.79	10.97	579
08/03/2014 19:30:32	23.74	10.61	581

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/03/2014 19:45:32	23.88	10.69	581
08/03/2014 20:00:32	24.06	10.76	580
08/03/2014 20:15:32	24.48	9.86	575
08/03/2014 20:30:32	24.12	9.73	578
08/03/2014 20:45:32	24.30	9.05	574
08/03/2014 21:00:32	24.08	9.06	575
08/03/2014 21:15:32	24.03	8.48	575
08/03/2014 21:30:32	24.05	7.80	577
08/03/2014 21:45:32	23.94	7.33	578
08/03/2014 22:00:32	24.39	6.96	566
08/03/2014 22:15:32	24.33	6.57	565
08/03/2014 22:30:32	24.25	6.57	566
08/03/2014 22:45:32	24.15	6.71	565
08/03/2014 23:00:32	24.06	6.97	565
08/03/2014 23:15:32	23.98	6.43	566
08/03/2014 23:30:32	23.88	6.41	567
08/03/2014 23:45:32	23.77	6.72	567
08/04/2014 00:00:32	23.67	6.65	567
08/04/2014 00:15:32	23.57	7.00	567
08/04/2014 00:30:32	23.48	6.92	568
08/04/2014 00:45:32	23.38	6.53	567
08/04/2014 01:00:32	23.33	6.41	567
08/04/2014 01:15:32	23.26	6.36	567
08/04/2014 01:30:32	23.14	6.00	568
08/04/2014 01:45:32	23.08	5.87	567
08/04/2014 02:00:32	22.96	6.11	568
08/04/2014 02:15:32	22.92	5.92	568
08/04/2014 02:30:32	22.87	5.97	569
08/04/2014 02:45:32	22.75	5.87	569
08/04/2014 03:00:32	22.70	5.83	569
08/04/2014 03:15:32	22.60	5.60	569
08/04/2014 03:30:32	22.53	5.48	569
08/04/2014 03:45:32	22.52	5.60	570
08/04/2014 04:00:32	22.44	5.59	571
08/04/2014 04:15:32	22.37	5.33	571
08/04/2014 04:30:32	22.28	5.21	571
08/04/2014 04:45:32	22.18	4.91	570
08/04/2014 05:00:32	22.15	4.65	570
08/04/2014 05:15:32	22.01	4.56	570
08/04/2014 05:30:32	21.95	4.08	569
08/04/2014 05:45:32	21.92	4.20	571
08/04/2014 06:00:32	21.84	4.30	572
08/04/2014 06:15:32	21.67	3.95	569
08/04/2014 06:30:32	21.58	4.03	572
08/04/2014 06:45:32	21.54	3.99	573
08/04/2014 07:00:32	21.45	3.69	572
08/04/2014 07:15:32	21.38	3.86	574

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/04/2014 07:30:32	21.31	3.55	575
08/04/2014 07:45:32	21.25	3.44	574
08/04/2014 08:00:32	21.22	3.26	574
08/04/2014 08:15:32	21.19	3.33	575
08/04/2014 08:30:32	21.20	4.08	575
08/04/2014 08:45:32	21.28	3.93	574
08/04/2014 09:00:32	21.39	4.02	573
08/04/2014 09:15:32	21.49	4.11	573
08/04/2014 09:30:32	21.62	4.80	575
08/04/2014 09:45:32	21.62	5.08	576
08/04/2014 10:00:32	21.64	5.21	577
08/04/2014 10:15:32	21.67	5.08	578
08/04/2014 10:30:32	21.73	5.24	580
08/04/2014 10:45:32	21.73	5.30	581
08/04/2014 11:00:32	21.79	5.36	582
08/04/2014 11:15:32	21.80	5.31	585
08/04/2014 11:30:32	21.85	5.45	586
08/04/2014 11:45:32	21.91	5.97	586
08/04/2014 12:00:32	22.03	6.63	587
08/04/2014 12:15:32	22.06	6.95	587
08/04/2014 12:30:32	22.09	7.28	588
08/04/2014 12:45:32	22.35	7.84	589
08/04/2014 13:00:32	22.38	8.48	589
08/04/2014 13:15:32	22.53	8.52	589
08/04/2014 13:30:32	22.56	9.16	589
08/04/2014 13:45:32	22.79	9.30	587
08/04/2014 14:00:32	22.97	9.83	586
08/04/2014 14:15:32	23.06	10.34	586
08/04/2014 14:30:32	23.19	10.89	588
08/04/2014 14:45:32	23.35	10.99	588
08/04/2014 15:00:32	23.51	11.58	588
08/04/2014 15:15:32	23.46	11.44	584
08/04/2014 15:30:32	23.52	11.70	585
08/04/2014 15:45:32	23.55	12.00	585
08/04/2014 16:00:32	23.62	12.16	585
08/04/2014 16:15:32	23.63	12.00	585
08/04/2014 16:30:32	23.66	11.85	585
08/04/2014 16:45:32	23.72	12.08	584
08/04/2014 17:00:32	23.69	11.68	584
08/04/2014 17:15:32	23.76	10.92	583
08/04/2014 17:30:32	23.79	10.68	582
08/04/2014 17:45:32	23.81	10.85	581
08/04/2014 18:00:32	24.01	11.90	580
08/04/2014 18:15:32	23.92	11.44	580
08/04/2014 18:30:32	23.79	11.02	581
08/04/2014 18:45:32	23.94	10.68	581
08/04/2014 19:00:32	23.87	10.46	582

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/04/2014 19:15:32	23.95	10.60	583
08/04/2014 19:30:32	24.09	10.58	582
08/04/2014 19:45:32	24.53	10.07	578
08/04/2014 20:00:32	24.07	10.16	582
08/04/2014 20:15:32	24.19	10.30	582
08/04/2014 20:30:32	24.23	10.33	582
08/04/2014 20:45:32	24.27	9.62	582
08/04/2014 21:00:32	24.21	9.15	582
08/04/2014 21:15:32	24.32	8.84	579
08/04/2014 21:30:32	24.29	8.54	575
08/04/2014 21:45:32	24.49	8.08	572
08/04/2014 22:00:32	24.51	7.87	570
08/04/2014 22:15:32	24.46	7.06	569
08/04/2014 22:30:32	24.45	6.46	567
08/04/2014 22:45:32	24.37	6.19	569
08/04/2014 23:00:32	24.37	6.14	566
08/04/2014 23:15:32	24.30	5.07	568
08/04/2014 23:30:32	24.24	4.99	568
08/04/2014 23:45:32	24.16	4.65	568
08/05/2014 00:00:32	24.06	5.12	567
08/05/2014 00:15:32	23.98	4.89	567
08/05/2014 00:30:32	23.89	5.40	567
08/05/2014 00:45:32	23.80	4.88	567
08/05/2014 01:00:32	23.73	4.12	567
08/05/2014 01:15:32	23.68	4.44	566
08/05/2014 01:30:32	23.59	4.09	566
08/05/2014 01:45:32	23.54	4.30	566
08/05/2014 02:00:32	23.46	4.41	566
08/05/2014 02:15:32	23.41	4.24	566
08/05/2014 02:30:32	23.36	4.21	566
08/05/2014 02:45:32	23.33	3.93	565
08/05/2014 03:00:32	23.28	4.46	564
08/05/2014 03:15:32	23.24	4.39	565
08/05/2014 03:30:32	23.15	4.68	561
08/05/2014 03:45:32	23.15	4.38	560
08/05/2014 04:00:32	23.12	4.37	560
08/05/2014 04:15:32	23.09	3.88	561
08/05/2014 04:30:32	23.02	4.40	560
08/05/2014 04:45:32	22.99	4.50	559
08/05/2014 05:00:32	22.98	4.69	558
08/05/2014 05:15:32	22.94	4.39	557
08/05/2014 05:30:32	22.90	4.20	556
08/05/2014 05:45:32	22.89	4.29	556
08/05/2014 06:00:32	22.86	4.52	558
08/05/2014 06:15:32	22.84	4.52	560
08/05/2014 06:30:32	22.83	4.12	556
08/05/2014 06:45:32	22.81	4.01	558

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/05/2014 07:00:32	22.80	3.97	558
08/05/2014 07:15:32	22.77	3.89	559
08/05/2014 07:30:32	22.77	4.01	560
08/05/2014 07:45:32	22.74	4.19	562
08/05/2014 08:00:32	22.72	3.80	563
08/05/2014 08:15:32	22.72	4.21	564
08/05/2014 08:30:32	22.73	4.26	567
08/05/2014 08:45:32	22.72	4.62	568
08/05/2014 09:00:32	22.72	4.77	569
08/05/2014 09:15:32	22.74	4.50	567
08/05/2014 09:30:32	22.75	5.24	569
08/05/2014 09:45:32	22.75	5.55	578
08/05/2014 10:00:32	22.76	6.01	578
08/05/2014 10:15:32	22.75	5.46	582
08/05/2014 10:30:32	22.79	5.61	584
08/05/2014 10:45:32	22.84	6.28	585
08/05/2014 11:00:32	22.86	6.26	587
08/05/2014 11:15:32	22.89	6.39	586
08/05/2014 11:30:32	22.92	7.13	585
08/05/2014 11:45:32	23.00	6.90	583
08/05/2014 12:00:32	23.11	7.47	582
08/05/2014 12:15:32	23.16	7.42	580
08/05/2014 12:30:32	23.27	7.72	574
08/05/2014 12:45:32	23.30	7.88	577
08/05/2014 13:00:32	23.60	8.26	579
08/05/2014 13:15:32	23.73	8.46	576
08/05/2014 13:30:32	23.92	9.25	574
08/05/2014 13:45:32	23.92	9.55	578
08/05/2014 14:00:32	23.98	9.83	577
08/05/2014 14:15:32	24.24	10.57	575
08/05/2014 14:30:32	24.20	11.10	579
08/05/2014 14:45:32	24.61	11.17	575
08/05/2014 15:00:32	24.65	11.88	576
08/05/2014 15:15:32	24.61	10.16	576
08/05/2014 15:30:32	24.58	10.56	577
08/05/2014 15:45:32	24.64	10.61	576
08/05/2014 16:00:32	24.68	10.48	575
08/05/2014 16:15:32	24.82	11.49	572
08/05/2014 16:30:32	24.75	11.52	572
08/05/2014 16:45:32	24.73	10.85	570
08/05/2014 17:00:32	24.67	10.34	572
08/05/2014 17:15:32	24.68	10.46	574
08/05/2014 17:30:32	24.68	10.57	577
08/05/2014 17:45:32	24.78	11.02	576
08/05/2014 18:00:32	24.72	11.18	579
08/05/2014 18:15:32	24.75	11.15	579
08/05/2014 18:30:32	24.88	10.79	579

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/05/2014 18:45:32	24.73	10.50	582
08/05/2014 19:00:32	24.77	10.47	582
08/05/2014 19:15:32	24.94	10.66	581
08/05/2014 19:30:32	25.10	9.65	580
08/05/2014 19:45:32	25.25	9.87	577
08/05/2014 20:00:32	25.14	9.06	576
08/05/2014 20:15:32	25.16	9.06	575
08/05/2014 20:30:32	25.16	8.65	575
08/05/2014 20:45:32	25.25	8.46	574
08/05/2014 21:00:32	25.15	7.94	575
08/05/2014 21:15:32	25.15	7.80	575
08/05/2014 21:30:32	25.14	7.74	575
08/05/2014 21:45:32	25.14	7.63	575
08/05/2014 22:00:32	25.46	6.82	566
08/05/2014 22:15:32	25.06	6.75	570
08/05/2014 22:30:32	25.05	6.32	575
08/05/2014 22:45:32	25.06	5.91	576
08/05/2014 23:00:32	25.06	5.63	575
08/05/2014 23:15:32	25.05	5.51	574
08/05/2014 23:30:32	25.06	4.98	573
08/05/2014 23:45:32	25.05	4.93	569
08/06/2014 00:00:32	25.00	3.74	568
08/06/2014 00:15:32	24.92	3.87	565
08/06/2014 00:30:32	24.83	3.40	562
08/06/2014 00:45:32	24.72	4.82	560
08/06/2014 01:00:32	24.63	4.55	560
08/06/2014 01:15:32	24.57	5.05	560
08/06/2014 01:30:32	24.51	4.13	561
08/06/2014 01:45:32	24.42	3.79	561
08/06/2014 02:00:32	24.31	4.29	561
08/06/2014 02:15:32	24.22	4.55	561
08/06/2014 02:30:32	24.16	4.45	560
08/06/2014 02:45:32	24.09	4.17	560
08/06/2014 03:00:32	24.01	4.25	560
08/06/2014 03:15:32	23.93	4.15	560
08/06/2014 03:30:32	23.85	4.13	560
08/06/2014 03:45:32	23.80	3.92	560
08/06/2014 04:00:32	23.74	3.86	560
08/06/2014 04:15:32	23.67	3.96	561
08/06/2014 04:30:32	23.59	3.81	561
08/06/2014 04:45:32	23.52	3.72	561
08/06/2014 05:00:32	23.46	3.51	561
08/06/2014 05:15:32	23.40	3.48	561
08/06/2014 05:30:32	23.32	3.43	562
08/06/2014 05:45:32	23.27	3.37	563
08/06/2014 06:00:32	23.21	3.38	563
08/06/2014 06:15:32	23.17	3.08	564

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/06/2014 06:30:32	23.11	3.25	564
08/06/2014 06:45:32	23.12	3.30	564
08/06/2014 07:00:32	23.07	3.27	564
08/06/2014 07:15:32	23.03	3.16	564
08/06/2014 07:30:32	23.01	3.00	564
08/06/2014 07:45:32	22.99	3.11	564
08/06/2014 08:00:32	23.03	2.46	566
08/06/2014 08:15:32	22.98	2.87	568
08/06/2014 08:30:32	23.05	2.94	567
08/06/2014 08:45:32	23.10	3.10	567
08/06/2014 09:00:32	23.18	3.35	567
08/06/2014 09:15:32	23.19	4.01	568
08/06/2014 09:30:32	23.21	4.12	569
08/06/2014 09:45:32	23.21	3.72	569
08/06/2014 10:00:32	23.27	4.27	569
08/06/2014 10:15:32	23.28	4.67	570
08/06/2014 10:30:32	23.31	4.66	572
08/06/2014 10:45:32	23.36	4.98	577
08/06/2014 11:00:32	23.36	5.64	579
08/06/2014 11:15:32	23.41	5.55	580
08/06/2014 11:30:32	23.44	6.31	582
08/06/2014 11:45:32	23.51	6.82	583
08/06/2014 12:00:32	23.63	6.95	581
08/06/2014 12:15:32	23.63	6.91	583
08/06/2014 12:30:32	23.78	7.41	584
08/06/2014 12:45:32	23.85	7.58	583
08/06/2014 13:00:32	24.09	8.30	584
08/06/2014 13:15:32	24.01	8.19	584
08/06/2014 13:30:32	24.29	8.96	581
08/06/2014 13:45:32	24.40	9.56	583
08/06/2014 14:00:32	24.58	9.81	581
08/06/2014 14:15:32	24.73	9.61	581
08/06/2014 14:30:32	24.74	9.70	580
08/06/2014 14:45:32	24.93	10.60	576
08/06/2014 15:00:32	24.99	11.38	581
08/06/2014 15:15:32	25.04	12.05	580
08/06/2014 15:30:32	25.13	12.01	577
08/06/2014 15:45:32	25.23	11.16	577
08/06/2014 16:00:32	25.27	11.91	576
08/06/2014 16:15:32	25.22	11.47	577
08/06/2014 16:30:32	25.39	11.55	576
08/06/2014 16:45:32	25.40	11.95	577
08/06/2014 17:00:32	25.43	11.64	577
08/06/2014 17:15:32	25.51	11.55	578
08/06/2014 17:30:32	25.36	11.98	581
08/06/2014 17:45:32	25.39	12.25	582
08/06/2014 18:00:32	25.33	11.03	583

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/06/2014 18:15:32	25.58	11.39	580
08/06/2014 18:30:32	25.49	10.82	581
08/06/2014 18:45:32	25.45	10.31	582
08/06/2014 19:00:32	25.77	9.80	576
08/06/2014 19:15:32	25.52	9.89	578
08/06/2014 19:30:32	25.52	9.54	579
08/06/2014 19:45:32	25.55	9.10	578
08/06/2014 20:00:32	25.64	8.60	573
08/06/2014 20:15:32	25.65	7.99	567
08/06/2014 20:30:32	25.60	7.73	567
08/06/2014 20:45:32	25.58	7.55	566
08/06/2014 21:00:32	25.50	7.39	565
08/06/2014 21:15:32	25.51	7.11	565
08/06/2014 21:30:32	25.52	7.02	565
08/06/2014 21:45:32	25.54	6.69	559
08/06/2014 22:00:32	25.46	6.15	560
08/06/2014 22:15:32	25.42	6.20	557
08/06/2014 22:30:32	25.40	5.81	557
08/06/2014 22:45:32	25.33	5.83	558
08/06/2014 23:00:32	25.25	6.21	559
08/06/2014 23:15:32	25.23	6.23	559
08/06/2014 23:30:32	25.21	5.62	559
08/06/2014 23:45:32	25.15	4.75	550
08/07/2014 00:00:32	25.07	4.52	548
08/07/2014 00:15:32	25.01	4.46	548
08/07/2014 00:30:32	24.99	3.95	548
08/07/2014 00:45:32	24.92	4.42	548
08/07/2014 01:00:32	24.85	4.23	549
08/07/2014 01:15:32	24.80	4.34	550
08/07/2014 01:30:32	24.77	4.35	550
08/07/2014 01:45:32	24.73	4.08	551
08/07/2014 02:00:32	24.63	4.09	549
08/07/2014 02:15:32	24.59	4.28	548
08/07/2014 02:30:32	24.56	4.46	550
08/07/2014 02:45:32	24.51	4.08	550
08/07/2014 03:00:32	24.47	3.82	550
08/07/2014 03:15:32	24.41	3.90	549
08/07/2014 03:30:32	24.38	4.04	549
08/07/2014 03:45:32	24.35	3.98	549
08/07/2014 04:00:32	24.31	3.99	549
08/07/2014 04:15:32	24.30	4.36	550
08/07/2014 04:30:32	24.25	4.22	551
08/07/2014 04:45:32	24.21	3.99	551
08/07/2014 05:00:32	24.17	3.75	550
08/07/2014 05:15:32	24.14	3.40	550
08/07/2014 05:30:32	24.11	3.47	551
08/07/2014 05:45:32	24.08	3.60	552

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/07/2014 06:00:32	24.05	3.46	552
08/07/2014 06:15:32	24.03	3.41	553
08/07/2014 06:30:32	23.97	3.24	553
08/07/2014 06:45:32	23.95	3.50	554
08/07/2014 07:00:32	23.89	3.10	553
08/07/2014 07:15:32	23.82	3.53	551
08/07/2014 07:30:32	23.77	4.16	566
08/07/2014 07:45:32	23.63	4.05	544
08/07/2014 08:00:32	23.53	3.98	530
08/07/2014 08:15:32	23.54	4.64	523
08/07/2014 08:30:32	23.61	4.98	530
08/07/2014 08:45:32	23.59	4.48	539
08/07/2014 09:00:32	23.62	4.28	542
08/07/2014 09:15:32	23.65	4.32	542
08/07/2014 09:30:32	23.63	4.19	546
08/07/2014 09:45:32	23.64	4.77	551
08/07/2014 10:00:32	23.63	5.01	554
08/07/2014 10:15:32	23.67	4.97	554
08/07/2014 10:30:32	23.68	5.05	555
08/07/2014 10:45:32	23.71	5.09	555
08/07/2014 11:00:32	23.74	4.95	554
08/07/2014 11:15:32	23.73	4.99	555
08/07/2014 11:30:32	23.76	5.04	552
08/07/2014 11:45:32	23.78	4.74	551
08/07/2014 12:00:32	23.78	4.94	550
08/07/2014 12:15:32	23.76	4.66	552
08/07/2014 12:30:32	23.76	4.67	554
08/07/2014 12:45:32	23.82	4.73	556
08/07/2014 13:00:32	23.87	5.07	556
08/07/2014 13:15:32	23.87	5.72	546
08/07/2014 13:30:32	23.84	5.58	546
08/07/2014 13:45:32	23.81	5.25	547
08/07/2014 14:00:32	23.86	4.97	548
08/07/2014 14:15:32	23.78	4.84	552
08/07/2014 14:30:32	23.78	4.64	549
08/07/2014 14:45:32	23.84	4.95	547
08/07/2014 15:00:32	23.85	4.78	542
08/07/2014 15:15:32	23.88	5.14	528
08/07/2014 15:30:32	23.86	5.28	528
08/07/2014 15:45:32	23.85	4.65	528
08/07/2014 16:00:32	23.86	4.78	517
08/07/2014 16:15:32	23.89	6.13	509
08/07/2014 16:30:32	23.95	5.93	510
08/07/2014 16:45:32	24.43	6.31	484
08/07/2014 17:00:32	24.49	6.80	490
08/07/2014 17:15:32	24.54	6.70	488
08/07/2014 17:30:32	24.58	6.79	482

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/07/2014 17:45:32	24.57	6.79	460
08/07/2014 18:00:32	24.52	6.64	436
08/07/2014 18:15:32	24.50	6.48	411
08/07/2014 18:30:32	24.45	6.49	387
08/07/2014 18:45:32	24.41	6.45	358
08/07/2014 19:00:32	24.39	6.42	357
08/07/2014 19:15:32	24.38	6.43	359
08/07/2014 19:30:32	24.37	6.42	368
08/07/2014 19:45:32	24.32	6.36	375
08/07/2014 20:00:32	24.29	6.35	385
08/07/2014 20:15:32	24.24	6.35	395
08/07/2014 20:30:32	24.19	6.29	406
08/07/2014 20:45:32	24.16	6.31	418
08/07/2014 21:00:32	24.13	6.26	428
08/07/2014 21:15:32	24.12	6.24	442
08/07/2014 21:30:32	24.11	6.31	461
08/07/2014 21:45:32	24.08	6.37	477
08/07/2014 22:00:32	24.02	6.38	497
08/07/2014 22:15:32	23.94	6.40	516
08/07/2014 22:30:32	23.84	6.39	530
08/07/2014 22:45:32	23.73	6.34	541
08/07/2014 23:00:32	23.65	6.31	543
08/07/2014 23:15:32	23.57	6.33	549
08/07/2014 23:30:32	23.47	6.32	553
08/07/2014 23:45:32	23.42	6.29	552
08/08/2014 00:00:32	23.42	6.29	545
08/08/2014 00:15:32	23.31	6.27	544
08/08/2014 00:30:32	23.26	6.25	539
08/08/2014 00:45:32	23.23	6.24	532
08/08/2014 01:00:32	23.19	6.23	526
08/08/2014 01:15:32	23.16	6.15	520
08/08/2014 01:30:32	23.16	6.15	514
08/08/2014 01:45:32	23.09	6.15	506
08/08/2014 02:00:32	23.05	6.16	501
08/08/2014 02:15:32	23.02	6.15	497
08/08/2014 02:30:32	22.99	6.14	493
08/08/2014 02:45:32	22.97	6.09	491
08/08/2014 03:00:32	22.95	6.09	490
08/08/2014 03:15:32	22.95	6.03	491
08/08/2014 03:30:32	22.90	6.07	489
08/08/2014 03:45:32	22.88	6.05	490
08/08/2014 04:00:32	22.85	6.05	488
08/08/2014 04:15:32	22.82	6.03	488
08/08/2014 04:30:32	22.79	6.03	488
08/08/2014 04:45:32	22.77	6.01	489
08/08/2014 05:00:32	22.77	6.01	491
08/08/2014 05:15:32	22.73	6.00	491

Date Time M/D/Y HH:MM:SS	Temp C	ODO mg/L	SpCond uS
08/08/2014 05:30:32	22.70	5.99	491
08/08/2014 05:45:32	22.69	5.98	492
08/08/2014 06:00:32	22.66	5.96	492
08/08/2014 06:15:32	22.65	5.94	493
08/08/2014 06:30:32	22.65	5.93	495
08/08/2014 06:45:32	22.62	5.92	495
08/08/2014 07:00:32	22.61	5.95	495
08/08/2014 07:15:32	22.63	5.93	496
08/08/2014 07:30:32	22.62	5.98	497
08/08/2014 07:45:32	22.62	6.02	497
08/08/2014 08:00:32	22.64	6.07	497
08/08/2014 08:15:32	22.67	6.13	498
08/08/2014 08:30:32	22.72	6.16	499
08/08/2014 08:45:32	22.76	6.26	499
08/08/2014 09:00:32	22.78	6.27	499
08/08/2014 09:15:32	22.82	6.38	499
08/08/2014 09:30:32	22.85	6.45	499
08/08/2014 09:45:32	22.90	6.52	499

Appendix D

Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report**Fox Cr [149804], Station #1, Sample Date: 3/20/2014 9:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	48	4	18
AMPHIPODA			
Crangonyx	-99		-99
Gammarus			1
Hyaella azteca			6
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae	2	2	
Lymnaeidae			2
Menetus	2	-99	9
Physella	3	-99	9
COLEOPTERA			
Berosus	18	2	3
Dubiraphia			8
Neoporus			1
Stenelmis	1		1
DIPTERA			
Ablabesmyia	4	10	12
Ceratopogoninae	2	20	10
Chironomidae	3	1	1
Chironomus	7	10	
Cladopelma		1	
Cladotanytarsus	2	16	
Clinotanypus	1		2
Corynoneura	1		1
Cricotopus/Orthocladius	71	7	7
Cryptochironomus	5		
Cryptotendipes		6	
Dicrotendipes	13	33	17
Eukiefferiella	3		
Glyptotendipes			3
Hemerodromia	1		
Hydrobaenus	7	1	11
Labrundinia			2
Micropsectra	5	3	
Microtendipes	1	1	
Nanocladius	8	1	8
Odontomyia		1	

Aquid Invertebrate Database Bench Sheet Report**Fox Cr [149804], Station #1, Sample Date: 3/20/2014 9:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Orthocladius (Euorthocladius)	3		
Parakiefferiella	1		1
Parametriocnemus	1		
Paraphaenocladius		1	5
Paratanytarsus	3	5	45
Paratendipes			1
Phaenopsectra	1		2
Polypedilum flavum	4	1	
Polypedilum halterale grp			2
Polypedilum illinoense grp			7
Procladius	2	11	1
Pseudochironomus		3	
Stempellinella	1		
Stictochironomus		2	
Sympotthastia	10		
Tanypus		1	
Tanytarsus	32	128	46
Thienemanniella	1		
Thienemannimyia grp.	11		2
Tribelos			2
Tvetenia bavarica grp	4		
Zavrelimyia			7
EPHEMEROPTERA			
Acerpenna	1		
Caenis latipennis	309	90	46
Centroptilum		1	1
Stenonema femoratum	18		
HEMIPTERA			
Belostoma			-99
ISOPODA			
Lirceus	4	-99	3
LUMBRICINA			
Lumbricina		-99	
ODONATA			
Argia	1		2
Enallagma		-99	5
Ischnura			4
PLECOPTERA			
Allocapnia	54	2	
TRICHOPTERA			
Cheumatopsyche	4		

Aquid Invertebrate Database Bench Sheet Report**Fox Cr [149804], Station #1, Sample Date: 3/20/2014 9:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Hydroptila	1		
Oecetis			1
Pycnopsyche			1
TRICLADIDA			
Planariidae	19		
TUBIFICIDA			
Branchiura sowerbyi		2	1
Tubificidae	5	3	8
VENEROIDA			
Pisidiidae			4

Aquid Invertebrate Database Bench Sheet Report**Fox Cr [149805], Station #2, Sample Date: 3/20/2014 11:55:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	5		
AMPHIPODA			
Crangonyx	10	15	17
Gammarus	15		7
Stygobromus		32	1
BASOMMATOPHORA			
Lymnaeidae			1
Physella		3	11
COLEOPTERA			
Enochrus			1
Psephenus herricki	1		
Stenelmis	1	2	
DECAPODA			
Orconectes virilis			1
DIPTERA			
Ceratopogoninae	1		
Chironomidae	3		
Chironomus	1	2	
Corynoneura		1	
Cricotopus/Orthocladius	18	5	2
Dicrotendipes		1	
Diptera	1		
Eukiefferiella	12		
Heterotrissocladius		1	
Hexatoma	3		
Hydrobaenus	2	4	5
Orthocladius (Euorthocladius)	1		
Parametriocnemus		3	
Paratanytarsus		1	
Procladius		2	
Prosimulium	2		
Pseudosmittia	1		
Sympothastia	7		12
Tanytarsus		2	
Thienemannimyia grp.		3	1
Tipula	2		1
Tvetenia bavarica grp	4		2
EPHEMEROPTERA			
Caenis latipennis		1	

Aquid Invertebrate Database Bench Sheet Report**Fox Cr [149805], Station #2, Sample Date: 3/20/2014 11:55:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Stenacron		1	
Stenonema femoratum		1	
ISOPODA			
Caecidotea	401	194	178
Caecidotea (Blind & Unpigmented)		2	
PLECOPTERA			
Allocapnia	93	1	4
Amphinemura	12		1
Chloroperlidae	1	1	
Leuctridae		5	
Perlinella drymo	1		
TRICHOPTERA			
Hydroptila			1
Ironoquia	1		3
Rhyacophila	3		
TUBIFICIDA			
Enchytraeidae	2		
Limnodrilus claparedianus		1	
Tubificidae	2	2	